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09/522,808	03/10/2000	David A. Molyneaux	MRI-100	5722

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EXAMINER
FETZNER, TIFFANY A

ART UNIT	PAPER NUMBER
2862	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.	Applicant(s)
09/522,808	Molyneaux et al.,
Examiner	**Art Unit**
Tiffany A. F tzner	2862

-- The MAILING DATE of this communication appears n the cover she t with th correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on *11/13/2001 & 11/21/2001*

2a) ☐ This action is **FINAL.** 2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) *1-45* is/are pending in the applica

4a) Of the above, claim(s) *18-24, 27-35, and 42-44* is/are withdrawn from considera

5) ☐ Claim(s) _____ is/are allowed.

6) ☒ Claim(s) *1-17, 25, 26, 36-41, and 45* is/are rejected.

7) ☐ Claim(s) _____ is/are objected to.

8) ☐ Claims _____ are subject to restriction and/or election requirem

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☒ The drawing(s) filed on *Mar 10, 2000* is/are objected to by the Examiner.

11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved.

12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

13) ☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

a) ☐ All b) ☐ Some* c) ☐ None of:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

*See the attached detailed Office action for a list of the certified copies not received.

14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

15) ☒ Notice of References Cited (PTO-892)

16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

17) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s). 4

18) ☒ Interview Summary (PTO-413) Paper No(s). 7

19) ☐ Notice of Informal Patent Application (PTO-152)

20) ☐ Other:

DETAILED ACTION

1. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

2. ***Election/Restriction***

The **election / restriction** mailed October 10th 2001, is **vacated** in view of the following **election / restriction**.

3. This application contains claims directed to the following patentably distinct species of the claimed invention: **Figures 1, 2, 3, 4, 5, 6, 7, 8, 9a, 9b, 10, 11, 13,** and **15a** each disclose separate embodiments of applicant's invention, as disclosed by applicant on pages 4 and 5 of applicant's disclosure..

4. Applicant is required under 35 U.S.C. 121 to elect a single disclosed species for prosecution on the merits to which the claims shall be restricted if no generic claim is finally held to be allowable. Currently, **no claims** are generic.

5. Upon the allowance of a generic claim, applicant will be entitled to consideration of claims to additional species which are written in dependent form or otherwise include all the limitations of an allowed generic claim as provided by 37 CFR 1.141. If claims are added after the election,

applicant must indicate which are readable upon the elected species. MPEP § 809.02(a). The examiner notes that as originally filed **no claims are generic**.

6. During a telephone conversation with **James S. Parker** Reg. No. 40,119 on Nov. 21st 2001 **a provisional election was made without traverse** to prosecute the invention of an MR coil configuration comprising a pair of coils and a single coil, **claims 1-17, 25, 26, 36-41,** and **45**; which correspond to **Figures 1 through 6** and **Figure 13**. Affirmation of this New election must be made by applicant in replying to this Office action.

7. **Claims 18-24, 27-35,** and **42-44**; **are withdrawn from further consideration** by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

8. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a petition under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(I).

Drawings

9. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description:

A) In **Figure 2,** reference components **4A', 5A', 6A'**; **4B, 5B, 6B**; and **5A** are not mentioned in applicant's disclosure.

B) In **Figure 3,** reference components **7A', 8A', 9A'**; **7B, 8B, 9B**; and **8A** are not mentioned in applicant's disclosure.

C) In **Figure 5**, reference components **28, 29,** and **30** are not mentioned in applicant's disclosure.

D In **Figure 6**, reference components **34 35,** and **36** are not mentioned in applicant's disclosure.

E) In **Figure 7**, reference component **13** is not mentioned in applicant's disclosure. Correction is required.

F) In **Figure 8**, reference components **19A, 20A, 21A, 22A, 21B**; and **22B** are not mentioned in applicant's disclosure.

G) In **Figure 9A**, reference components **16A** and **18A** are not mentioned in applicant's disclosure.

H) In **Figure 9B**, reference components **14A**, **15A** and **17A** are not mentioned in applicant's disclosure.

I) In **Figure 12**, reference components **C1, C2, C3**, and **C4** are not mentioned in applicant's disclosure.

J) In Figure **13**, reference components **72A, 71A, 70A**; and the five loop reference components **A, B, C, D**, and **E** are not mentioned in applicant's disclosure.

K) In **Figures 15A**, **15B,** and **15C** reference components **98** and **99** are not mentioned in applicant's disclosure. The examiner also notes that applicant's detailed description does not mention **Figure 15A**.

L) In **Figure 16**, reference components **I1, I2, R1, R2, x1, x2**, and **xo** are not mentioned in applicant's disclosure. Correction is required.

10. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description:

A) **Figure 5** does show loops **23, 24,** and **25** as taught on page 8 line 27.

B) **Figure 6** does show loops **23, 24,** and **25** as taught on page 9 line 5.

Correction is required.

11. Applicant is required to submit a proposed drawing correction in response to this Office Action. Any proposal by the applicant for amendment of the drawings to cure defects **must consist of two parts:**

A. A separate letter to the Draftsman in accordance with M.P.E.P. (608.02(r); and

B. A print or pen-and-ink sketch showing changes in red ink in accordance with M.P.E.P. (608.02(v)).

IMPORTANT NOTE: The filing of new formal drawings to correct the noted defect may be deferred until the application is allowed by the examiner, but the print or pen-and-ink sketch with proposed corrections shown in red ink is required in response to this Office Action, and *may not be deferred.*

Detailed art rejections of claims elected without traverse

12. **Claims 1-17, 25, 26, 36-41,** and **45**; which correspond to **Figures 1 through 6** and **Figure 13** of applicant's original disclosure were **elected without traverse** by applicant on Nov. 21st 2001 via the telephone interview with applicant's attorney **James S. Parker** Reg. No. 40,119.

13. **Claims 18-24, 27-35,** and **42-44**; **are withdrawn from further consideration**.

Claim Rejections - 35 USC § 102

14. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless --
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claim Rejections - 35 USC § 103

15. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

16. The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

17. **Claims 1-11, 13-17, 38-41** and **45** are rejected under **35 U.S.C. 102(b)** as being anticipated by **Mehdizadeh et al.**, US patent 4,918,388 issued 17 April 1990 filed 19 August 1988; or, in the alternative, under **35 U.S.C. 103(a)** as obvious over **Mehdizadeh et al.**, US patent 4,918,388 issued 17 April 1990.

18. With respect to **Claim 1**, and **corresponding method claim 41**, **Mehdizadeh et al.**, teaches and shows "A coil configuration for a magnetic resonance imaging system, comprising: a pair of coils in an opposite rotation orientation" [See Helmholtz, D-pair 32 in Figures 6, 7; which are shown to be "in an opposite rotation orientation"] "associated with a first magnetic field in a region of interest;" [See col. 2 lines 10-12, col. 3 lines 60-65 where the Helmholtz or D-pair coil is taught to be associated with the horizontal magnetic field.] Additionally, **Mehdizadeh et al.**, teaches "a single coil (i.e. coil loop coil 30) "associated with a second magnetic field in the region of interest, [See col. 2 lines 10-12, col. 3 lines 55-57; where the loop coil is taught to be associated with the vertical magnetic field.] **Mehdizadeh et al.**, also suggests "the single coil is positioned at an essentially zero-flux contour with respect to the first magnetic field" because, **Mehdizadeh et al.**, teaches that the symmetry of the coil configuration creates a condition of 'zero' mutual coupling (i.e. zero-magnetic flux) which allows a region of interest along the x-y plane (i.e. broadly interpreted by the examiner as an x-y magnetic contour) to create a circularly polarized field. [See col. 4 lines 7-13; See Figures 6, 7, 8, and 9]

19. With respect to **Claim 2, Mehdizadeh et al.**, teaches "a means for utilizing the pair of coils for detecting the first magnetic field; (i.e. by making use of the symmetrical arrangement of the coils) and a means for utilizing the single coil for detecting the second magnetic field", (i.e. by making use of the symmetrical arrangement of the coils) [See col. 3 lines 50-65]. The same reasons for rejection, that apply to **claim 1** also apply to **claim 2**.

20. With respect to **Claim 3, Mehdizadeh et al.**, teaches "a means for utilizing the pair of coils" (i.e. Helmholtz coil pair 32) "for generating the first magnetic field"; (i.e. producing a

horizontal field) "and a means for utilizing the single coil (i.e. loop coil pair 30) for generating the second magnetic field." (i.e. producing a vertical field) [See col. 2 lines 9-12, col. 3 lines 50-65]. The same reasons for rejection, that apply to **claim 1** also apply to **claim 3**.

21. With respect to **Claim 4, Mehdizadeh et al.**, teaches "a means for utilizing the pair of coils" (i.e. Helmholtz coil pair 32) "for generating the first magnetic field"; (i.e. producing a horizontal field) "and a means for utilizing the single coil (i.e. loop coil pair 30) for generating the second magnetic field." (i.e. producing a vertical field) [See col. 2 lines 9-12, col. 3 lines 50-65]. The same reasons for rejection, that apply to **claims 1, 2** also apply to **claim 4**.

22. With respect to **Claim 5, Mehdizadeh et al.**, shows that the coil configuration of "said coils of said pair of coils and said single coil are selected from the group consisting of: a single turn loop, [See component 30 in Figures 2, 3, 6, 7, 8, and 9], a multiturn solenoid wound as series loops, [See component 32 in Figures 6 7] and a multiturn solenoid wound as parallel loops." [See component 32 figures 1, 2, 9]. The same reasons for rejection, that apply to **claims 1, 2** also apply to **claim 5**.

23. With respect to **Claim 6, Mehdizadeh et al.**, teaches and shows that "each of said pair of coils (i.e. the D-Pair or Helmholtz coil 32) and said single coil (i.e. coil 30) lie in planes parallel to each other, and wherein said essentially zero-flux contour is an essentially zero-flux plane." [See Figure 3, col. 2 lines 7-12; col. 3 lines 66 through col. 4 line 13; col. 4 lines 16-21] The same reasons for rejection, that apply to **claim 1** also apply to **claim 6**.

24. With respect to **Claim 7, Mehdizadeh et al.**, suggests from the figures that " the region of interest is essentially within a cylinder created by the pair of coils, [See Figure 1, col. 4 and

wherein the pair of coils and the single coil are co-axial." The same reasons for rejection, that apply to **claims 1, 6** also apply to **claim 7**.

25. With respect to **Claim 8 Mehdizadeh et al.**, lacks explicitly stating that "the single coil is a first channel and the pair of coils is a second channel such that coupling between the first channel and second channel is low." However, **Mehdizadeh et al.**, teaches that the coil configuration allows quadrature detection to be performed. [See col. 2 lines 5-12] It is well-known and well-established in the art of MRI / NMR that in quadrature detection there is inherently at least one channel per coil, with a minimum of two coils; and then a 90 degree phase shift to impart quadrature. Figure 2 of **Mehdizadeh et al.**, shows a tunning and matching circuit associated with single coil 30, (i.e. component 42) and a tunning and matching circuit associated with D-Pair or Helmholtz coil 32, (i.e. component 42); therefore the presence of at least two channels are suggested, from Figure 2. Additionally, **Mehdizadeh et al.**, also teaches that coil 30 is shorter and about 50% as wide as coil 32, which creates a condition of zero mutual coupling between the coils for proper quadrature operation. [See col. 4 lines 6-9] This teaching of 'zero mutual coupling' is inherently a low coupling between the inherent channel of coil 30 suggested from figure 2, and the inherent channel of coil 32, suggested by Figure 2. Therefore, the examiner considers the limitation that "the single coil is a first channel and the pair of coils is a second channel such that coupling between the first channel and second channel is low", to be directly suggested, and inherent, from the teachings and illustrations of the **Mehdizadeh et al.**, reference. The same reasons for rejection, that apply to **claims 1, 2** also apply to **claim 8**.

26. With respect to **Claim 9**, **Mehdizadeh et al.**, suggests that "the coupling between the first channel" (i.e. the inherent channel of coil 32 suggested from figure 2), "and second channel" (i.e. the inherent channel of coil 30 suggested from figure 2), "is approximately zero", because zero mutual coupling is taught. [See col. 3 line 66 through col. 4 line 13] The same reasons for rejection, that apply to **claims 1, 2, 8** also apply to **claim 9**.

27. With respect to **Claim 10, Mehdizadeh et al.**, suggests from the figures that "the zero-flux contour is located between the pair of coils." [See figures, 6, 8; where the curved coil configuration produces a contour "between the pair of coils"]. The same reasons for rejection, that apply to **claim 1** also apply to **claim 10**.

28. With respect to **Claim 11, Mehdizadeh et al.**, suggests from the figures that "the zero-flux contour is located outside the pair of coils." [See figures 1, 3, where the flat coil configuration produces a contour "outside the pair of coils"; col. 4 lines 9-13]. The same reasons for rejection, that apply to **claim 1** also apply to **claim 11**.

29. With respect to **Claim 13, Mehdizadeh et al.**, shows that "the single coil (i.e. loop coil 30) is positioned approximately equidistance from each of the pair of coils." [See Figures 1, 3, 6, 7, 8, 9] The same reasons for rejection, that apply to **claims 1, 10** also apply to **claim 13**.

30. With respect to **Claim 14, Mehdizadeh et al.**, shows that "the single coil is positioned closer to one of the coils of the pair of coils than to the other." [See Figure 2 where one side of the Helmholtz pair 32 is shown closer to loop coil 30.] The same reasons for rejection, that apply to **claims 1, 10** also apply to **claim 14**.

31. With respect to **Claim 15, Mehdizadeh et al.**, suggests and shows that "at least one Helmholtz coil pair [See D coil pair 32 which is also taught as a Helmholtz coil pair] "associated with a third magnetic field essentially orthogonal to the first and second magnetic fields in the region of interest", because coil pair 32, in Figure 7, which is taught as being associated with the horizontal components [See col. 2 lines 10-12, col. 3 lines 60-65] is also shown as being orthogonally oriented. Therefore, the z-axis magnetic field (i.e. the magnetic field that is orthogonal to the vertical and horizontal magnetic fields) and in conventionally present in MR applications, is inherently associated with Helmholtz pair 32 in Figure 7. The same reasons for rejection, that apply to **claims 1,** also apply to **claim 15**.

32. With respect to **Claim 16, Mehdizadeh et al.**, shows "a means for utilizing said at least one Helmholtz coil pair for generating the third magnetic field." [See the geometrical orientation, and location of Helmholtz pair 32 in Figure 7]. It is the examiner's position that the position and orientation of the Helmholtz coils, when energized in the course of executing the pulse sequence, generate the third magnetic field, (interpreted as a z-axis magnetic field). The same reasons for rejection, that apply to **claims 1, 15** also apply to **claim 16**.

33. With respect to **Claim 17, Mehdizadeh et al.**, shows that the "Helmholtz coil pair is of a configuration selected from the group consisting of: large loops, [See Figures 6, 7, 8] "top/bottom loops", [See Figure 9 which suggests top/bottom loops, since side by side loops rotated 90 degrees become top/bottom loops] side by side loops [See Figure 9], "and a combination thereof."[See Figures 6, 7, 8, 9] The same reasons for rejection, that apply to **claims 1, 15** also apply to **claim 17**.

34. With respect to **Claim 38**, **Mehdizadeh et al.**, shows teaches and suggests "A coil configuration for a magnetic resonance imaging system, comprising: a plurality of coils with bilateral symmetry" [See Figures 6, 7, and 9;], "wherein said plurality of coils is associated with a plurality of modes" (i.e. transmit and receive mode); The limitation that "the number of modes is less than or equal to the number of coils" is suggested from the fact that the **Mehdizadeh et al.**, reference teaches at least two coils, and since the coils can operate in a transmit or receive mode, two operational modes for the RF frequency are taught (i.e. transmission mode, and reception mode). It is well-known to have a mode for transmission alone, reception alone, or a transmit/receive coil, which performs both functions but only functions in one mode. Therefore, the **Mehdizadeh et al.**, reference teaches, and suggests a possibility of at least two modes of operation in general. The **Mehdizadeh et al.**, reference is considered by the examiner to read on, teach, and suggest situations where the number of modes is less than, or equal to the number of coils present.

35. The **Mehdizadeh et al.**, reference also teaches, shows, and suggests that the "plurality of modes correspond with a plurality of current patterns, each of said plurality of current patterns having zero net mutual inductive coupling to each of the other of said plurality of current patterns in a region of interest." [See Figures 3, 6, 7, 8, and 9] The same reasons for rejection, that apply to **claim 1** also apply to **claim 38** concerning "zero net mutual inductive coupling" and need not be reiterated The examiner considers each coil configuration suggestive of a separate coil pattern.

36. With respect to **Claim 39**, **Mehdizadeh et al.**, shows and suggests "a means for utilizing the plurality of coils for detecting magnetic fields associated with the plurality of current

patterns." [See Figure 1 receiver 60] The same reasons for rejection, that apply to **claims 1, 38** also apply to **claim 39.**

37. With respect to **Claim 40**, **Mehdizadeh et al.**, shows and suggests "a means for utilizing the plurality of coils for **generating** magnetic fields associated with the plurality of current patterns." [See Figure 1 RF. transmitter 18 and gradient field control 14] The same reasons for rejection, that apply to **claims 1, 38** also apply to **claim 40.**

38. With respect to **Claim 45**, **Mehdizadeh et al.**, shows, and suggests "A method of detecting magnetic fields in a magnetic resonance imaging system, comprising the following steps: positioning a plurality of coils with respect to a region of interest such that the plurality of coils support a plurality of modes (i.e. a transmit and receive mode) corresponding to a plurality of current patterns;" [See Figures 6, 7, 8, and 9 which suggest different coil pattern configurations. **Mehdizadeh et al.**, also teaches, and suggests the step of "detecting the plurality of modes associated with the plurality of coils, wherein the number of coils is greater than or equal to the number of modes, and wherein each of the plurality of current patterns has zero net mutual inductive coupling to each of the other of the plurality of current patterns in a region of interest" for the same reasons given in the rejections of **claims 1, 38**, and **39**, of this action that need not be reiterated.

39. **Claims 1, 10, 12, 36, 37, 38-41** and **45** are rejected under **35 U.S.C. 102(b)** as being anticipated by **Molyneaux**, US patent 5,394,087 issued 28 February 1995 filed 11 August 1993; or, in the alternative, under **35 U.S.C. 103(a)** as obvious over **Molyneaux**, US patent 5,394,087 issued 28 February 1995 filed 11 August 1993

40. With respect to **Claim 1**, and **corresponding method claim 41 Molyneaux**, teaches and shows "A coil configuration for a magnetic resonance imaging system, comprising: a pair of coils in an opposite rotation orientation" [See Figure 2, abstract, Figure 9, Figure 10; which are shown to be "in an opposite rotation orientation"] "associated with a first magnetic field in a region of interest;" [See abstract where the Helmholtz coil is taught to be associated with the components parallel to the plane of the coil (i.e. the horizontal magnetic field components).]. Additionally, **Molyneaux**, teaches "a single coil (i.e. loop coil 50 in the abstract or loop coil52sub2 in Figures 9, 10) "associated with a second magnetic field in the region of interest, [See abstract where the loop coil is taught to be associated with the components perpendicular to the plane of the coil (i.e. the vertical magnetic field components).] **Molyneaux**, also suggests "the single coil 50 is positioned at an essentially zero-flux contour with respect to the first magnetic field" because, **Molyneaux**, teaches that the coils are dimensioned and positioned such that there is minimum mutual inductance, and sensitivity is orthogonal [See col. 4 lines 11-16] The teaching of is minimum mutual inductance suggests a symmetrical configuration of 'zero' mutual coupling (i.e. a zero-magnetic flux) in an orthogonal plane (i.e. broadly interpreted by the examiner as a zero-flux magnetic contour).

41. With respect to **Claim 10, Molyneaux**, suggests from figures 9, 10 that "the zero-flux contour is located between the pair of coils." [See Figures 9 and Figure 10; where the curved coil configuration inherently produces a contour "between the pair of coils". (i.e. from Figure 9 there is suggested by illustration a "zero-flux contour" that reads as "being located between the pair of coils." The examiner notes that the teaching of minimizing the coupling between the coils, in the

abstract and col. 5 lines 31-36 implicitly suggests at least one "substantially zero magnetic flux contour".] The same reasons for rejection, that apply to **claim 1** also apply to **claim 10**.

42. Fix With respect to **Claim 12, Molyneaux**, suggests that "a second zero-flux contour with respect to the first magnetic field is located outside the pair of coils", (i.e. the zero-flux contour which occurs along the axis of coil 52sub1 and 52sub2 occurs outside the zero-flux contour defined by Helmholz coil 54sub2 and 54sub1) "further comprising a second single coil" (i.e. coil loop 52sub1 in Figures 9, 10) "for generating a third magnetic field in the region of interest, (interpreted as along the z-axis or the axis orthogonal to the horizontal and vertical directions) "wherein the second single coil" (i.e. coil loop 52sub1 in Figures 9, 10) is positioned at the second zero-flux contour with respect to the first magnetic field", [See Figures 9. 10]. As mentioned in the rejection of **claim 1**, all the coils are positioned to minimize coupling therefore the presence of the additional single loop coil in figures 2, 9, and 10 inherently suggests that Figures 2, 9, and 10, comprise at least an additional (i.e. a second) zero magnetic flux contour. The same reasons for rejection, that apply to **claims 1, 10** also apply to **claim 12**.

43. With respect to **Claim 36**, the **Molyneaux** reference suggests "at least one additional pair of coils, wherein said pair of coils in an opposite orientation has odd symmetry with respect to a plane, wherein each of said at least one additional pair of coils is associated with a corresponding at least one additional magnetic field, wherein each of said at least one additional pair of coils has even symmetry with respect to the plane and is associated with one of said at least one additional magnetic field such that said single coil is a first channel, said pair of coils in an opposite orientation is a second channel, and each of said at least one additional pair of coils is an

additional channel which is orthogonal to the first channel, second channel, and each of the other additional channels." [See Figures 9, 8, 10; col. 5 lines 10-15, and col. 3 line 25 through col. 5 line 67 in general.] The examiner notes that a quadrature coil configuration inherently has separate channels per coil, and that an additional coil pair(s) suggest additional channels. The symmetry and orthogonality limitations are suggested from Figures 9, 8, and 10 as illustrated. That the additional pair of coils can have an opposite current orientation is suggested from the teaching that counter rotating loop coils can be used. [col. 5 lines 10-15] The same reasons for rejection, that apply to **claim 1** also apply to **claim 36**.

44. With respect to **Claim 37**, the **Molyneaux** reference suggests "at least one additional pair of coils, wherein said pair of coils in an opposite orientation has odd symmetry with respect to a plane, wherein each of said at least one additional pair of coils is associated with a corresponding at least one additional magnetic field, wherein each of said at least one additional pair of coils has odd symmetry with respect to the plane and is associated with one of said at least one additional magnetic field such that said single coil is a first channel, said pair of coils in an opposite orientation is a second channel, and each of said at least one additional pair of coils is an additional channel which is orthogonal to the first channel, second channel, and each of the other additional channels." [See Figures 9, 8, 10; col. 5 lines 10-15, and col. 3 line 25 through col. 5 line 67 in general.] As mentioned in the rejection of claim 36, a quadrature coil configuration inherently has separate channels per coil, and an additional coil pair(s) suggests additional channels. The symmetry and orthogonality limitations are suggested from Figures 9, 8, and 10 as illustrated. Even and odd symmetry is suggested by the coil configurations depicted in [Figures 8,

9, and 10] That the additional pair of coils can have an opposite current orientation is suggested from the teaching that counter rotating loop coils can be used. [col. 5 lines 10-15] The same reasons for rejection, that apply to **claims 1, 36** also apply to **claim 37**.

45. With respect to **Claim 38**, **Molyneaux**, shows teaches and suggests "A coil configuration for a magnetic resonance imaging system, comprising: a plurality of coils with bilateral symmetry" [See Figures 2,7, 8, 9, and 10;], "wherein said plurality of coils is associated with a plurality of modes" (i.e. transmit and receive mode); The limitation that "the number of modes is less than or equal to the number of coils" is suggested from the fact that the **Molyneaux**, reference teaches at least two coils, and since the coils can operate in a transmit or receive mode, two operational modes for the RF frequency are taught (i.e. transmission mode, and reception mode), [See col. 5 lines 64-67]. It is well-known to have a mode for transmission alone, reception alone, or a transmit/receive coil, which performs both functions but only functions in one mode. Therefore, the **Molyneaux**, reference teaches, and suggests a possibility of at least two modes of operation in general. The **Molyneaux**, reference is considered by the examiner to read on, teach, and suggest situations where the number of modes is less than, or equal to the number of coils present.

46. The **Molyneaux**, reference also teaches, and suggests that the "plurality of modes correspond with a plurality of current patterns, each of said plurality of current patterns having zero net mutual inductive coupling to each of the other of said plurality of current patterns in a region of interest." [See Figures 1,2, 7, 8, 9, and 10] The same reasons for rejection, that apply to **claim 1** also apply to **claim 38** concerning "zero net mutual inductive coupling" and need not be reiterated The examiner considers each coil configuration suggestive of a separate coil pattern.

47. With respect to **Claim 39**, **Molyneaux**, shows and suggests "a means for utilizing the plurality of coils for detecting magnetic fields associated with the plurality of current patterns." [See Figure 1 receivers 32,1; 32,2; and 32,3] The same reasons for rejection, that apply to **claims 1, 38** also apply to **claim 39.**

48. With respect to **Claim 40**, **Molyneaux**, shows and suggests "a means for utilizing the plurality of coils for **generating** magnetic fields associated with the plurality of current patterns." [See Figure 1 transmitter 20 and gradient control 16] The same reasons for rejection, that apply to **claim 38** also apply to **claim 40.**

49. With respect to **Claim 45**, **Molyneaux**, shows, and suggests "A method of detecting magnetic fields in a magnetic resonance imaging system, comprising the following steps: positioning a plurality of coils with respect to a region of interest such that the plurality of coils support a plurality of modes (i.e. a transmit and receive mode) corresponding to a plurality of current patterns;" [See Figures 1,2, 7, 8, 9, and 10 which suggest different coil pattern configurations]. **Molyneaux**, also teaches, and suggests the step of "detecting the plurality of modes associated with the plurality of coils, wherein the number of coils is greater than or equal to the number of modes, and wherein each of the plurality of current patterns has zero net mutual inductive coupling to each of the other of the plurality of current patterns in a region of interest" for the same reasons given in the rejections of **claims 38**, and **39**, of this action that need not be reiterated.

50. **Claims 25**, is rejected under **35 U.S.C. 103(a)** as being unpatentable over **Mehdizadeh et al.**, US patent 4,918,388 issued 17 April 1990.

51. With respect to **Claim 25, Mehdizadeh et al.**, lacks teaching that the "pairs of coils are connected together by a pair of electrical conductors to form an Alderman-Grant coil pair." However, in Figures 6, and 7 **Mehdizadeh et al.**, shows full black circles which the examiner interprets as locations to which "electrical conductors" can be connected. Therefore, It would have been obvious to one of ordinary skill in the art, at the time that the invention was made, that the "pairs of coils" of **Mehdizadeh et al.**, "are connected together by a pair of electrical conductors". Additionally since "pairs of coils connected together by a pair of electrical conductors" implicitly suggest an "Alderman-Grant coil pair", it is the examiner's position that the ability to form a "Alderman-Grant coil pair" is suggested from the **Mehdizadeh et al.**, reference.

52. **Claim 26** is rejected under **35 U.S.C. 103(a)** as being unpatentable over **Mehdizadeh et al.**, US patent 4,918,388 issued 17 April 1990; in view of **Molyneaux**, US patent 5,394,087 issued 28 February 1995 filed 11 August 1993.

53. With respect to **Claim 26**, **Mehdizadeh et al.**, teaches and shows switching or jumper lead assemblies 108, 110 which select which signal is to be shifted by 90 degrees. [See Figure 5 col. 5 lines 12-15; claim 15 in col. 7 line 37 through col. 8 line 11] This suggests that the single coil 30 and the double coil 32, can produce signals independent of each other. The coils 30, and 32 (i.e. single coil 30, and double coil 32 depicted in Figure 7 are considered as being operable by the circuitry of Figure 5, by the examiner based on the teachings of col. 5 lines 1-4. Therefore, **Mehdizadeh et al.**, teaches and suggests by the illustration of Figures 6, 7, 8, and 9 "a switching means for allowing the pair of coils (i.e. 32) and the single coil (i.e. 30) to operate in and switch between **two or more** of the modes in the group consisting of: (I) the coils of the pair of coils and

the single coil having currents rotating in the same direction; (ii) the coils of the pair of coils having currents rotating in the same direction, with the single coil operating independently; (iii) the coils of the pair of coils having currents rotating in opposite directions, with the single coil operating independently; and (iv) the coils of the pair of coils having currents rotating in the same direction and the single coil having a current rotating in an opposite direction with respect to the currents of the pair of coils." [See Figures 6, 7, 8 and 9 where the illustrations of the coil designs suggest that the current flowing through the coils, dependent on the configuration selected, with conduct current in either the same direction (i.e. figure 8) or opposite directions (i.e. Figures 6, 7, and 9)], Therefore, each of applicant's modes is suggested, by the **Mehdizadeh et al.**, reference.

54. Additionally, the examiner notes that **Molyneaux** reference teaches that the counter-rotating loop coils (i.e. coils which inherently have current flowing in opposite directions) and double loop coils can be utilized. [See col. 5 lines 10-15] This teaching suggests that having current flowing in the same, or opposite directions, through a coil configuration consisting of a single coil, and at least a double loop coil is already conventionally, well-known in the MRI, NMR art. The teachings of the **Mehdizadeh et al.**, reference can be combined with the teachings of the **Molyneaux** reference because the **Molyneaux** reference, refers specifically to the **Mehdizadeh et al.**, reference [See col. 1 lines 29-39] and one of the inventors, David **A. Molyneaux,** is a co-inventor of the **Mehdizadeh et al.**, reference. Additionally, MRI coil configuration design is the main goal of both references. The same reasons for rejection, that apply to **claim 1** for the **Mehdizadeh et al.**, and **Molyneaux** references also apply to **claim 26**.

55. **Claims 38-40,** and **45** are rejected under **35 U.S.C. 102(b)** as being anticipated by **Vavrek et al.**, US patent 5,311,135 issued May 10th 1994; or alternatively **Claims 38-40,** and **45** are rejected under **35 U.S.C. 103(a)** as being unpatentable over **Vavrek et al.**, US patent 5,311,135 issued May 10th 1994.

56. With respect to **Claim 38**, **Vavrek et al.**, shows teaches and suggests "A coil configuration for a magnetic resonance imaging system, comprising: a plurality of coils with bilateral symmetry" [See Figures 2, 3, and 9; abstract, col. 2 lines 18-64, col. 3 line 25 through col. 7 line 64], "wherein said plurality of coils is associated with a plurality of modes" (i.e. transmit and receive mode; additionally each coil is taught to have a plurality of operational modes, to allow the termination point, or effective size of each active gradient coil to change, dependent upon the switch configuration used). [See Figures 2, 3, and 9; abstract, col. 2 lines 18-64, col. 3 line 25 through col. 7 line 64], The limitation that "the number of modes is less than or equal to the number of coils" is suggested from the fact that the **Vavrek et al.**, reference teaches at least four coils, and three separate operational modes for the activation size of the applied gradients, (i.e. operating each coil in either mode A, mode B, or mode C). Additionally since the coils can operate in a transmit or receive mode only two operational modes for the RF frequency are taught (i.e. transmission mode, and reception mode). It is well-known to have a mode for transmission alone, reception alone, or a transmit/receive coil, which performs both functions but only functions in one mode. Therefore, the **Vavrek et al.**, reference teaches, and suggests a possibility of 2, 3, 4, or five modes of operation in general. The **Vavrek et al.**, reference is

considered by the examiner to read on, teach, and suggest situations where the number of modes is less than, greater than, or equal to the number of coils present.

57. The **Vavrek et al.**, reference also teaches, and suggests that the "plurality of modes correspond with a plurality of current patterns, each of said plurality of current patterns having zero net mutual inductive coupling to each of the other of said plurality of current patterns in a region of interest." [See Figures 4, 5, 6, and 7; col. 3 line 25 through col. 7 line 64]

58. With respect to **Claim 39**, **Vavrek et al.**, shows "a means for utilizing the plurality of coils for detecting magnetic fields associated with the plurality of current patterns." [See Figure 1 the transceiver module of system control 16. Col. 3 line 42 through col. 4 line 24 and the entire reference in general.] The same reasons for rejection, obviousness, and motivation to combine that apply to **claim 38** also apply to **claim 39.**

59. With respect to **Claim 40**, **Vavrek et al.**, teaches, and suggests "a means for utilizing the plurality of coils for **generating** magnetic fields associated with the plurality of current patterns." [See Figure 1 the transceiver module of system control 16. Col. 3 line 42 through col. 4 line 24 and the entire reference in general.] The same reasons for rejection, obviousness, and motivation to combine that apply to **claim 38** also apply to **claim 40.**

60. With respect to **Claim 45**, **Vavrek et al.**, teaches, and suggests "A method of detecting magnetic fields in a magnetic resonance imaging system, comprising the following steps: positioning a plurality of coils with respect to a region of interest such that the plurality of coils support a plurality of modes corresponding to a plurality of current patterns;" [See Figures 2 through 9, the abstract, col. 2 lines 18-64, and col. 3 line 25 through col. 7 line 64.] The examiner

notes that each of the **Vavrek et al.**, coils supports mode A, mode B and mode C as illustrated in Figures 3 and 9; that each of these modes generates a different coil pattern is illustrated in Figures 4, 5, 6, and 7. **Vavrek et al.**, also teaches, and suggests the step of "detecting the plurality of modes associated with the plurality of coils, wherein the number of coils is greater than or equal to the number of modes, and wherein each of the plurality of current patterns has zero net mutual inductive coupling to each of the other of the plurality of current patterns in a region of interest" for the same reasons given in the rejections of **claims 38**, and **39**, of this action that need not be reiterated. The same reasons for rejection, that apply to **claims 38, 39, 40** also apply to **claim 45.**

Conclusion

61. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tiffany Fetzner whose telephone number is (703) 305-0430. The examiner can normally be reached on Monday-Thursday from 7:00am to 4:30pm., and on alternate Friday's from 7:00am to 3:30pm.

62. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Hezron Williams, can be reached on (703) 305-4705. The fax phone number for the organization where this application or proceeding is assigned is (703)305-3432 .

63. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 305-0956.

Tiffany A. Fetzner

TAF

November 30, 2001

HEZRON WILLIAMS
SUPERVISORY PATENT EXAMINER
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